Contribution ID: **15** Type: **Poster**

A Lightweight First-Level Muon Track Trigger for Future Hadron Collider Experiments

Thursday, 20 September 2018 18:15 (15 minutes)

Single muon triggers are crucial for the physics programmes at hadron collider experiments. To keep the trigger rates reasonable low they must be highly selective.

Muon system at LHC experiments and at future colliders use two muon chamber system for triggering. Fast trigger chambers, identifying the bunch crossing and providing a course momentum estimation, and slower precision chambers, for precise measurements of the muon trajectory.

A fast lightweight track finding algorithm, based on the Hough Transform and Linear Regression techniques, has been designed and implemented on a Zynq SoC device, reconstructing successfully muon tracks in a single trigger sector.

Summary

Single muon triggers are crucial for the physics programmes at hadron collider experiments. To be sensitive to electroweak processes, single muon triggers with transverse momentum thresholds down to 20 GeV and dimuon triggers with even lower thresholds are required.

In order to keep the rates of these triggers at an acceptable level these triggers have to be highly selective, i.e. they must have small accidental trigger rates and sharp trigger turn-on curves. The muon systems of the LHC experiments and experiments at future colliders like FCC-hh will use two muon chamber systems for the muon trigger, fast trigger chambers like RPCs with coarse spatial resolution and much slower precision chambers like drift-tube chambers with high spatial resolution.

The data of the trigger chambers are used to identify the bunch crossing in which the muon was created and for a rough momentum measurement while the precise measurements of the muon trajectory by the precision chambers are ideal for an accurate muon momentum measurement.

A fast lightweight track finding algorithm is presented, where muon track candidates are reconstructed using a binning algorithm based on a 1D Hough Transform. The algorithm has been designed and implemented on a System-On-Chip device. A hardware demonstration using Xilinx Evaluation boards ZC706 has been set up to prove the concept. It successfully reconstructs tracks in a trigger sector made of three layers of muon chambers.

The conceptual studies are based on LHC collision data, simulated data, and results from laboratory tests and test-beam campaigns with demonstrator hardware for such a trigger system.

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Session Classification: Posters

Track Classification: Trigger